New susceptibility measurement devices and their calibration

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Contents

Objectives

Determination of the complex magnetic susceptibility.

Calibration of devices devoted to susceptibility determination

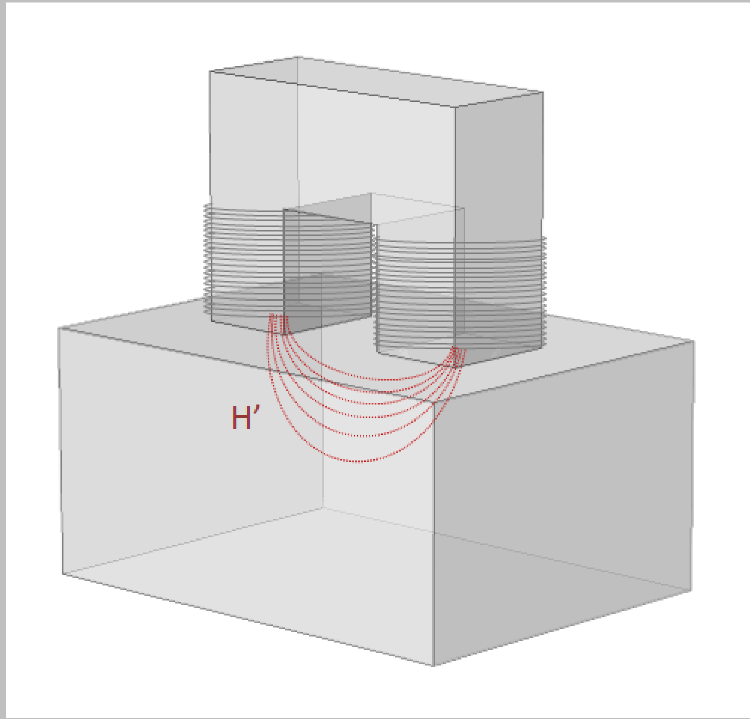
Geological and planetary magnetic surveys

Devices

Commercial devices

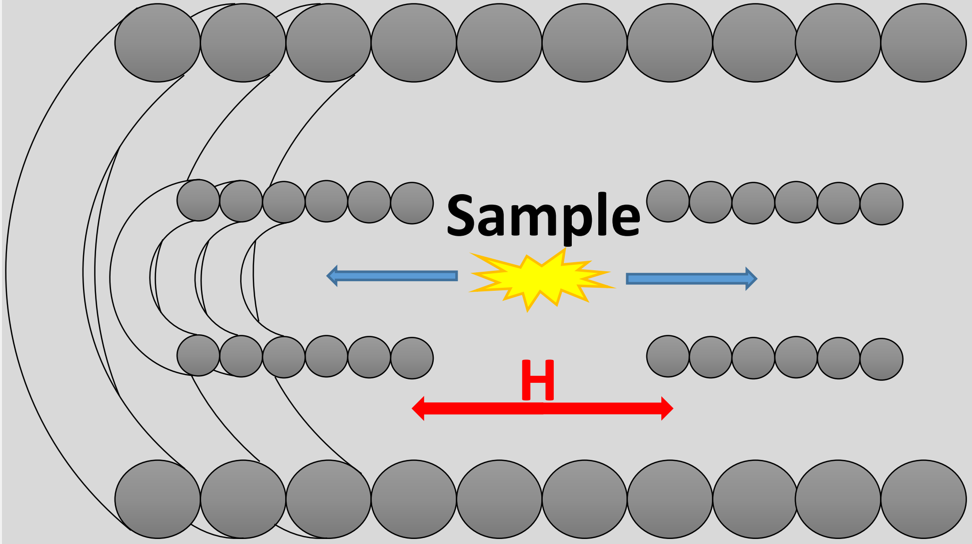
- Squids based (PPMS).
- Few portable instruments.
- MS2E Surface scanning sensor.
- Working frequency from 1.36 to 2 kHz.
- Only real component.

Portable susceptometer



Reference: J.L. Mesa, A. B. Fernandez , G. Mcintosh , F. Martin-Hernandez , M. L. Osete , M. Maicas , C. Aroca , M. Diaz-Michelena. "Compact uni-axial magnetic susceptometer for planetary mineralogy". INTERMAG 2014. AF-07.

Fixed susceptometer (MO.E.1_03)

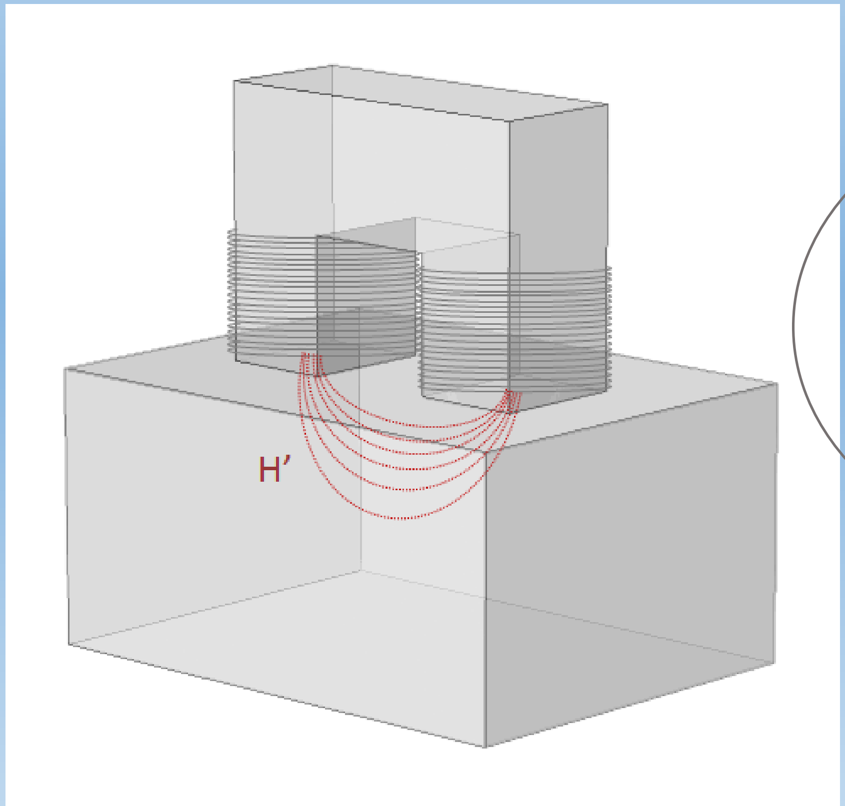


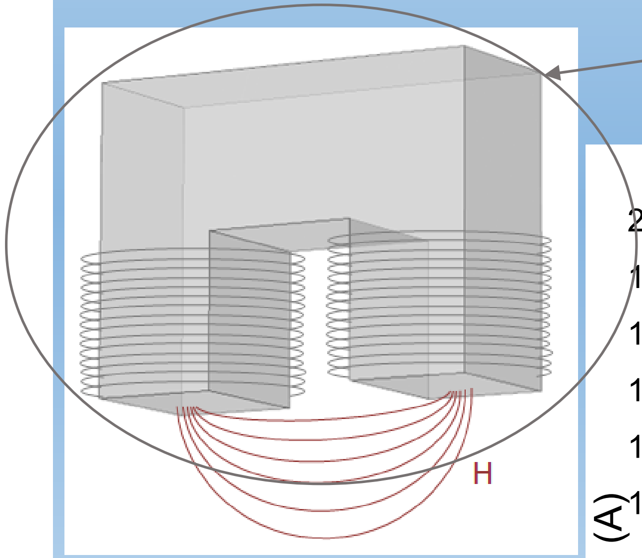
Phase and quadrature analisys of the EMF

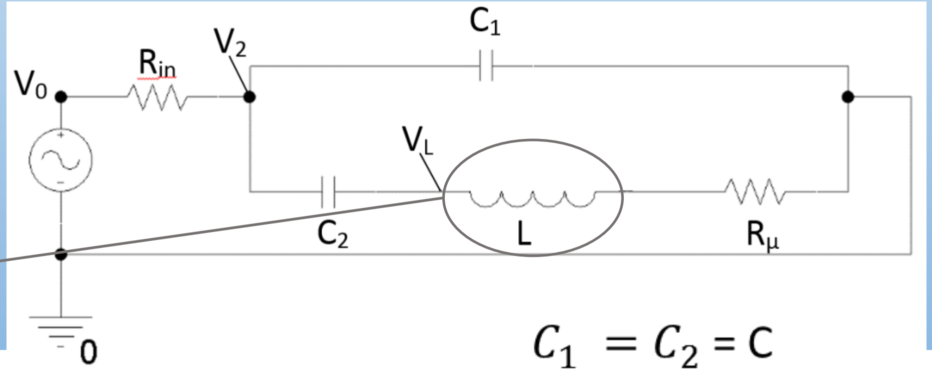
$$\boxed{\mu' = \alpha \frac{\varepsilon_x}{mass}} \qquad \boxed{\mu'' = \beta \frac{\varepsilon_Y}{mass}}$$

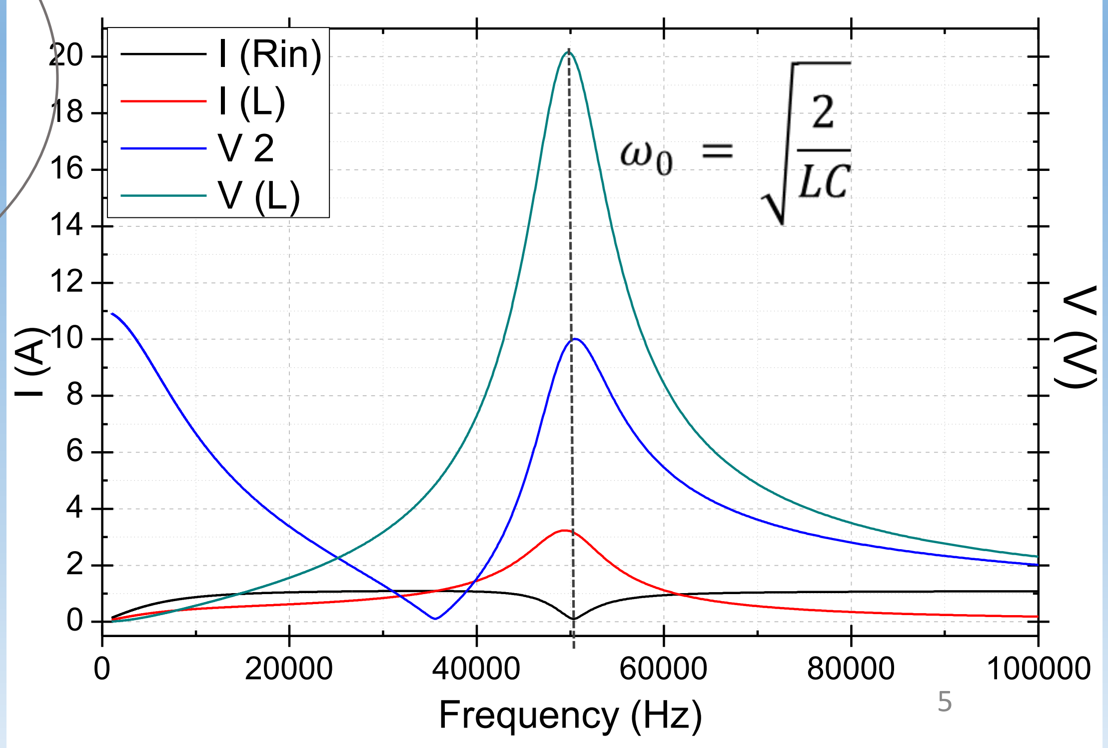
Reference: P. Cobos, M. Maicas, M. Sanz, and C. Aroca. "High Resolution System for Nanoparticles Hyperthermia Efficiency Evaluation". IEEE Transactions on magnetics, vol. 47, No. 10, October 2011.

Portable susceptometer design









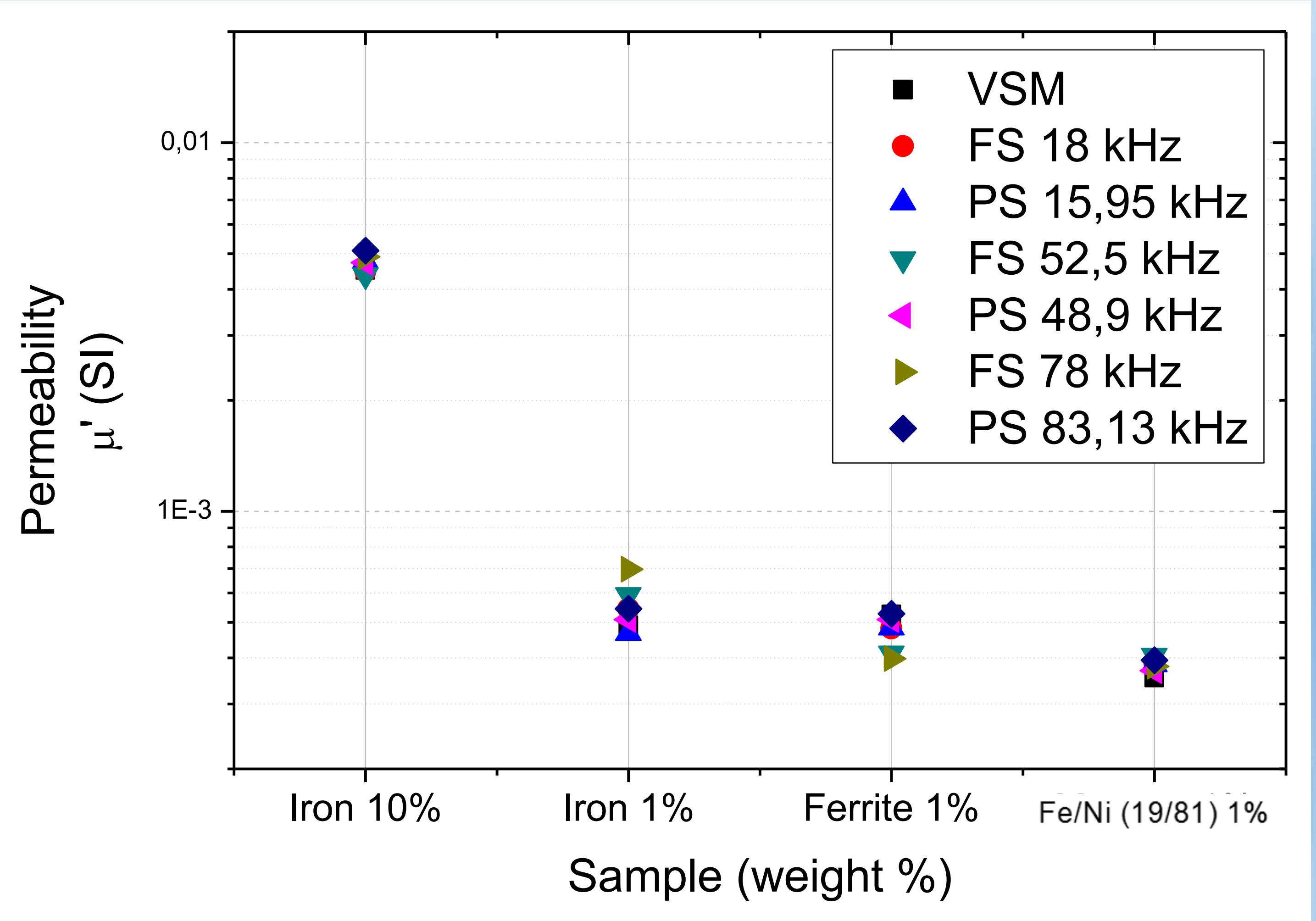
$$\boxed{\mu'_{sample} = \Delta L \cdot \mathrm{K} + \mu_0}$$

Calibration

Manufactured epoxi samples.

Sample	Material	Percentage
Iron 10%	Iron powder	10% total weight
Iron 1%	Iron powder	1% total weight
Ferrite 1%	Ferrite powder	1% total weight
Metglas	Iron/Niquel 19/81	1% total weight

α and K are the proportionality factors.

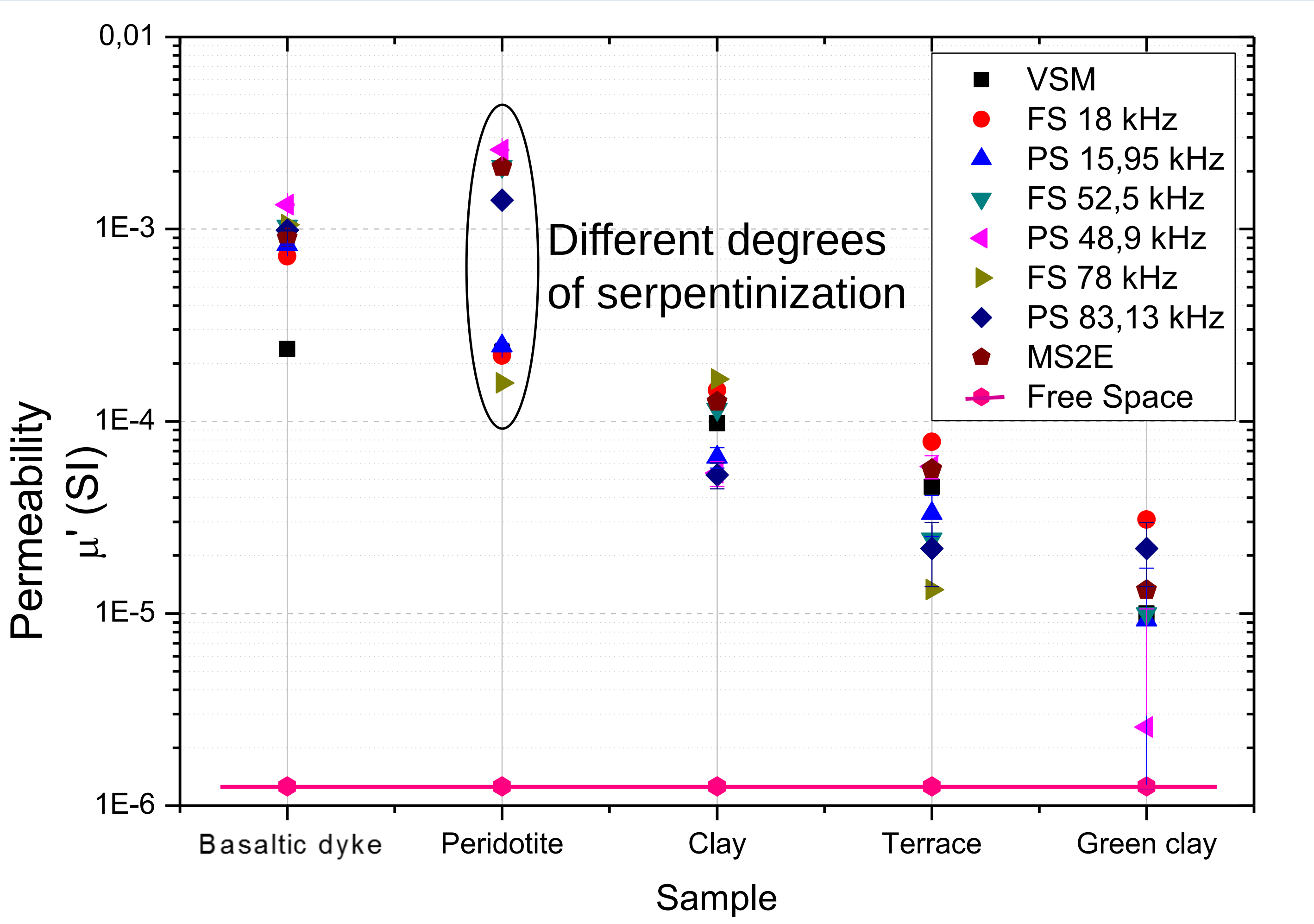


PS = Portable susceptometer $\boxed{\mu'_{sample} = \Delta L \cdot \mathrm{K} + \mu_0}$

FS = Fixed susceptometer $\boxed{\mu' = \alpha \frac{\varepsilon_x}{mass}}$

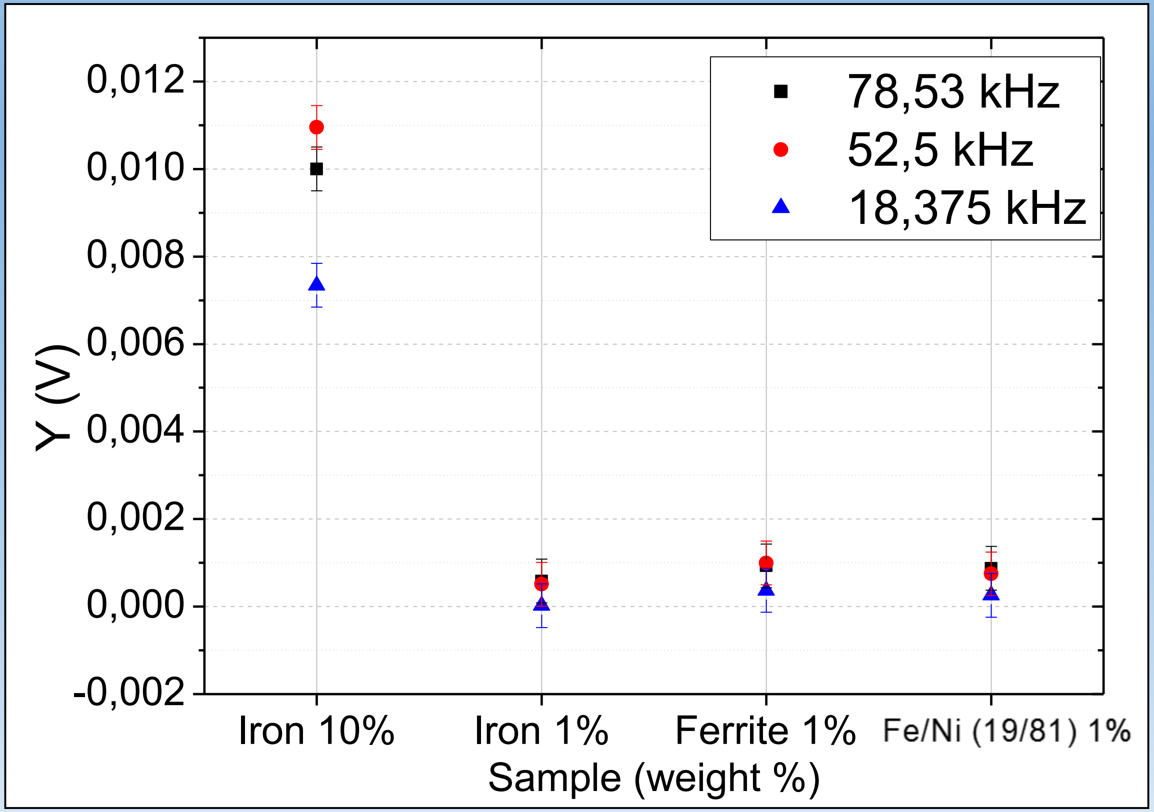
Results

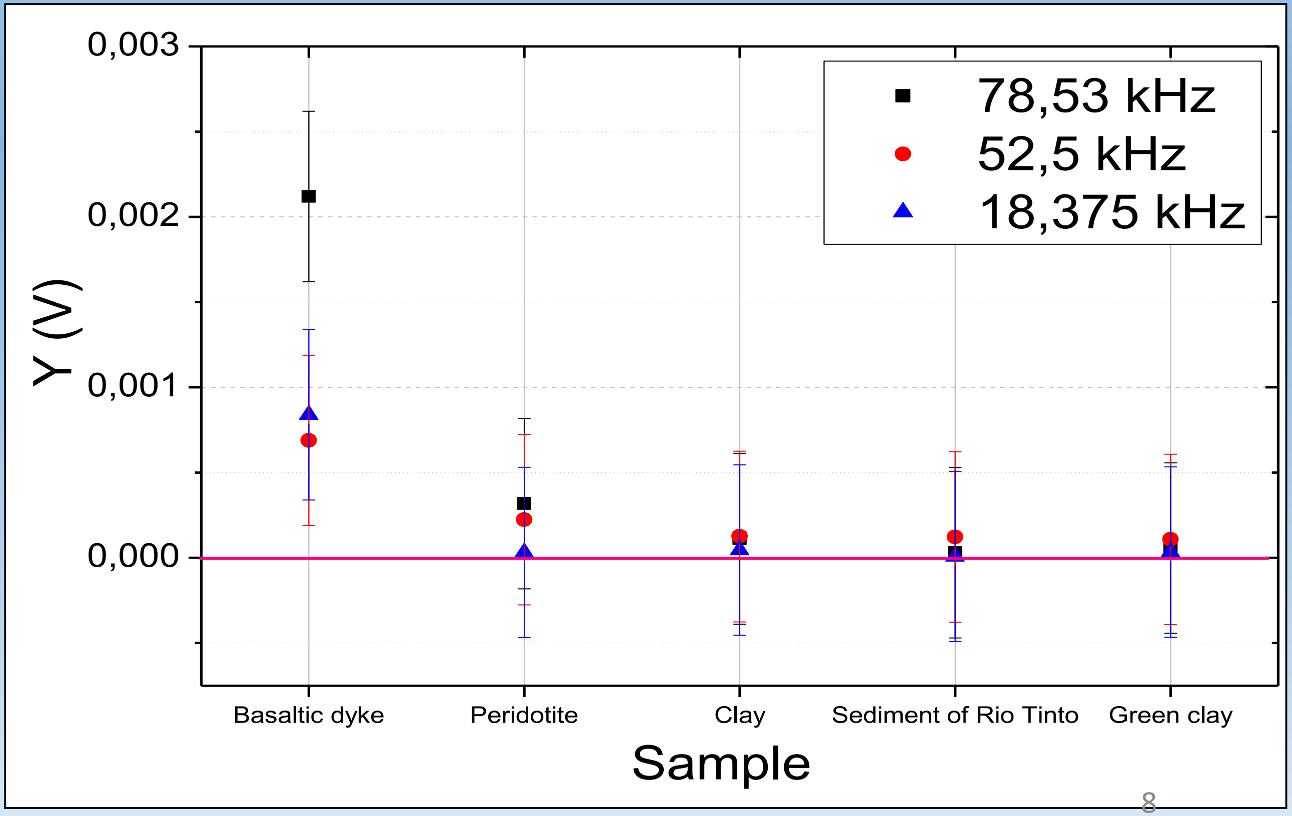
- Natural samples of relevant scenarios.
- The peridotite shows two appreciable distinct values.
- The variation in the values are due to the inhomogeneity of the samples.
- Terrace sample obtained in Río Tinto (Spain), a Mars analogue scenario.



Imaginary component of the complex permeability 1

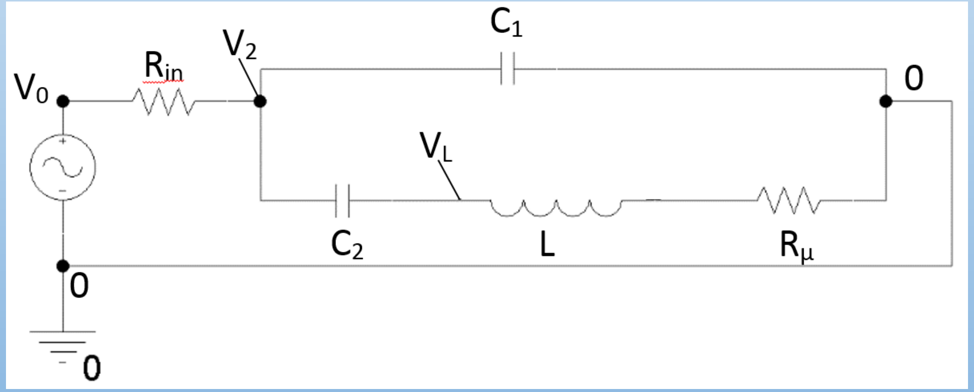
Fixed susceptometer $\mu'' = \beta \frac{\varepsilon_y}{mass}$

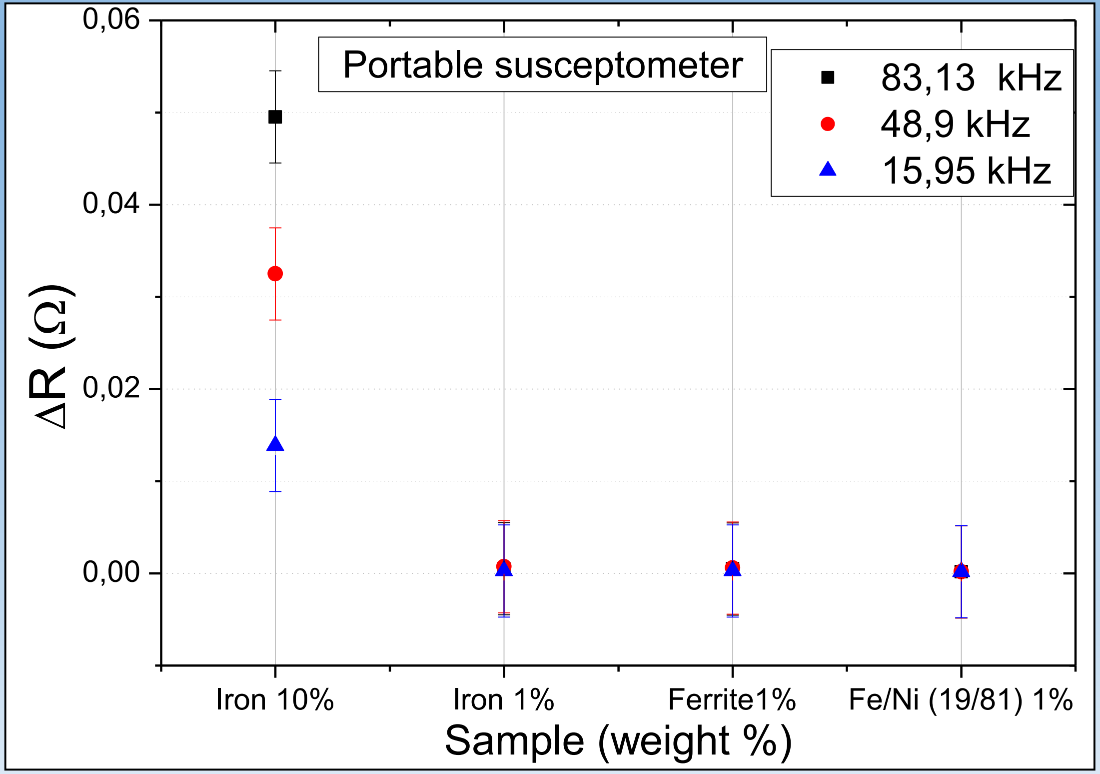


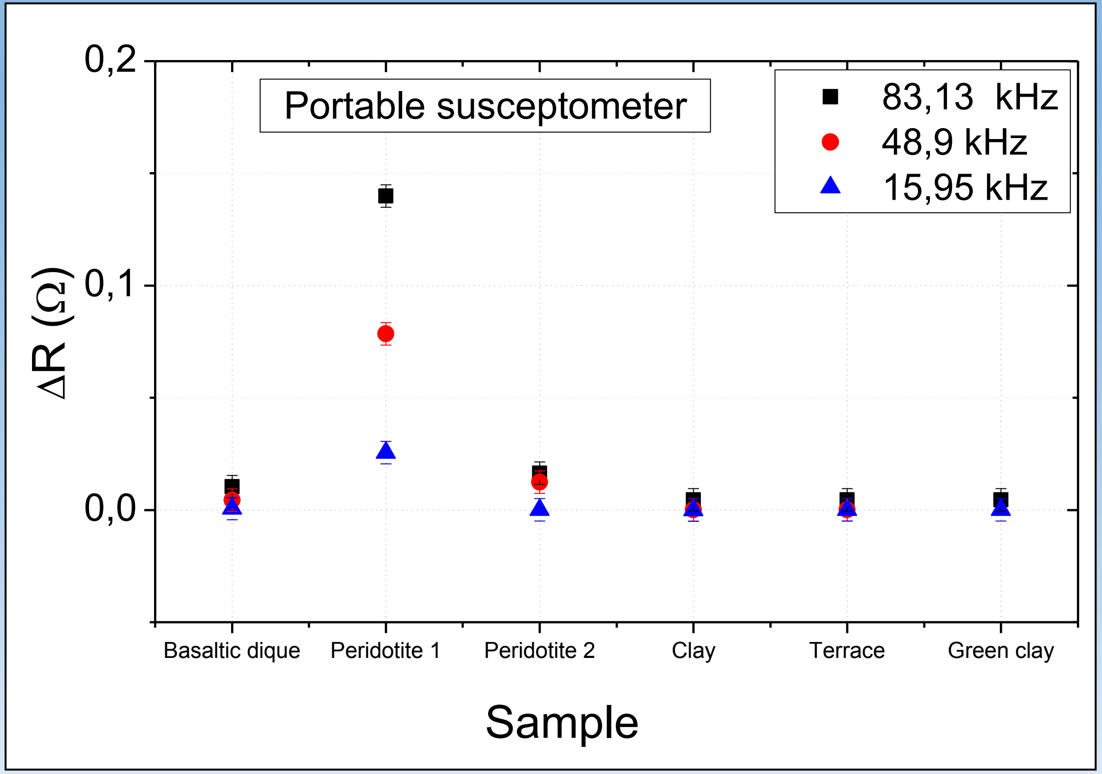


Imaginary component of the complex permeability 2

$$\mu'' = \beta' R_\mu = \frac{\Delta V_{Rin}}{R_{in} V_2^{\,2} \omega_0 C^2}\left(2V_0 - V_{Rin}\right)$$







Summary

- Construction and calibration of two devices for the measurement of the complex magnetic susceptibility of natural samples.
- Good agreement with a reference commercial susceptometer. Successful calibration for real part of the complex permeability.
- It is possible to perform in-situ determination of magnetic susceptibility in geological and planetary exploration.

Following steps:

- To calibrate the complex part to obtain magnitudes.
- To prove reliability of the portable susceptometer on a field survey.

Thank you for your kind attention!